



# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference JKH/P102834PCT		<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/GB 03/04082	International filing date (day/month/year) 15.09.2003	Priority date (day/month/year) 10.10.2002	
International Patent Classification (IPC) or both national classification and IPC A61N5/04			
Applicant MICROSULIS LIMITED et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 4 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"><li>I <input checked="" type="checkbox"/> Basis of the opinion</li><li>II <input type="checkbox"/> Priority</li><li>III <input checked="" type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li><li>IV <input type="checkbox"/> Lack of unity of invention</li><li>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li><li>VI <input type="checkbox"/> Certain documents cited</li><li>VII <input type="checkbox"/> Certain defects in the international application</li><li>VIII <input type="checkbox"/> Certain observations on the international application</li></ul>			
Date of submission of the demand  10.05.2004		Date of completion of this report  12.11.2004	
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer  Artikis, T  Telephone No. +49 89 2399-7923  	

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB 03/04082

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

2-9 as originally filed  
1 received on 22.10.2004 with letter of 19.10.2004

**Claims, Numbers**

1-18 received on 22.10.2004 with letter of 19.10.2004

**Drawings, Sheets**

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 12-18

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☒ no international search report has been established for the said claims Nos. 12-28

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the Standard.

☐ the computer readable form has not been furnished or does not comply with the Standard.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1-11
	No: Claims	
Inventive step (IS)	Yes: Claims	1-11
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-11
	No: Claims	

2. Citations and explanations

**see separate sheet**

Form PCT/PEA/409 (January 2004)

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**Re Item III**

**Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

1. No examination will be carried out in respect of claims 12 to 18, because they are original claims 13-19 which have not been searched (see Art. 17(2)(a) or (3) PCT, Rule 66.1(e) PCT and the international search report).

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

2. Reference is made to the following documents:

D1: US-A-4 446 874 (VAGUINE VICTOR A) 8 May 1984 (1984-05-08)

D3: EP-A-0 294 854 (UNIV GLASGOW) 14 December 1988 (1988-12-14)

3. **INDEPENDENT CLAIM 1**

- 3.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document) a microwave applicator (see abstract, lines 1-3) comprising:

- a coaxial electrical input (see col. 7, lines 49-51 and figure 4 (132));
- a waveguide filled with dielectric (see col. 5, lines 25-27 and 50-53); and
- an inner conductor of the coaxial input extending longitudinally within one end of the waveguide (see col. 7, lines 45-60 and figure 4).

The subject-matter of claim 1 differs from D1 in that microwaves in the  $TM_{01}$  are launched. The subject-matter of claim 1 is therefore novel (Article 33(2) PCT).

- 3.2. The problem to be solved by the present invention may be regarded as how to select the mode of the microwaves.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The apparatuses disclosed in D1 explicitly operate in the  $TE_{01}$  or the  $TE_{11}$  mode

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depending on whether a rectangular or a cylindrical waveguide is used (see col. 6, lines 41-49). Therefore, the person skilled in the art would not even consider modifying these known apparatuses in order to make them launch microwaves in the  $TM_{01}$  mode.

Furthermore, document D3, which is the only available prior art document referring to the  $TM_{01}$  mode of propagation, discloses (see abstract and figure 8) a microwave thermography apparatus comprising a cylindrical waveguide capable of supporting both the  $TE_{11}$  and the  $TM_{01}$  mode and a mode transformer in the shape of a rod in order to block the  $TM_{01}$  mode and thus leave the  $TE_{11}$  mode only.

Consequently, the subject-matter of claim 1 involves an inventive step (Art. 33(3) EPC).

4. CLAIMS 2-8

Claims 2-8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

5. CLAIMS 9-11

Claim 9 comprises all the features of claim 1 and is therefore not appropriately formulated as a claim dependent on the latter (Rule 6.4 PCT). Consequently, claim 9 also meets the requirements of the PCT with respect to novelty and inventive step.

The same applies to claims 10-11, which are dependent on claim 9 and thus on claim also.

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MICROWAVE APPLICATORTechnical Field

This invention relates to a microwave applicator suitable for heating biological tissue and a method of heat treating surface tissue.

The applicants have previously proposed a microwave applicator for surgical use comprising a waveguide of reduced diameter by virtue of containing a dielectric of high permittivity. A coaxial electrical input generates microwaves in the  $TE_{11}$  mode within the dielectric and these radiate from the distal end face of the waveguide.

Disclosure of the Invention

According to a first aspect, the present invention, consists in a microwave applicator comprising a coaxial electrical input and a waveguide filled with dielectric, a central conductor of the coaxial input extending longitudinally within one end of the waveguide to launch microwaves in the  $TM_{01}$  mode, to travel to the distal end face of the waveguide so that microwaves are transmitted from the distal end face when in contact with the biological tissue to be treated.

The  $TM_{01}$  mode is selected because it has a field pattern that is a good match with the coaxial input, better than the fundamental  $TE_{11}$  mode more commonly used. The  $TM_{01}$  also produces a simple transition between the coaxial input and the waveguide. The central conductor is preferably coaxially aligned within a circular waveguide and extends a short way within the waveguide to match the general dimensions of the waveguide, especially its length and diameter, and the permittivity of the dielectric and frequency of the electrical input.

The distal end face of the waveguide is preferably flat and radiates microwave energy with parallel wavefronts that advance into the biological tissue in contact with the distal end face and have minimum lateral spreading. The depth of penetration of the microwaves is dependent upon the frequency and electrical input power, but typically only a small distance of penetration is required for local heat treatment of tissue in microsurgery. In an

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CLAIMS

1. A microwave applicator comprising a coaxial electrical input (4) and a waveguide (1) filled with dielectric (2), an inner conductor (7) of the coaxial input (4) extending longitudinally within one end of the waveguide (1) to launch microwaves in the  $TM_{01}$  mode to travel to the distal end face (8) of the waveguide (1) so that microwaves are transmitted when the distal end face (8) is contacted by biological tissue to be treated.
2. A microwave applicator as claimed in claim 1 in which the inner conductor (7) is axially aligned with the waveguide (1).
3. A microwave applicator as claimed in claim 1 or 2 in which the waveguide (1) is a circular waveguide.
4. A microwave applicator as claimed in any one of the preceding claims in which the distal end face (8) is substantially flat and normal to the axis of the waveguide (1).
5. A microwave applicator as claimed in any one of claims 1 to 3 in which the distal end face (8) is flat or slightly domed and centred on the axis of the waveguide (1).
6. A microwave applicator as claimed in any one of the preceding claims in which the distal end face (8) has a polymer coating (22).
7. A microwave applicator as claimed in any one of the preceding claims in which the length and diameter of the waveguide (1), the length of the inner conductor (7) within the waveguide, and the permittivity of the dielectric material (2) are selected so that at the designed operating frequency, the waveguide is in resonance.
8. A microwave applicator as claimed in any one of the preceding claims in which the waveguide (1) is adapted so that in operation, when the distal end face (8) is in contact with biological tissue to be treated, forwards transmission from the distal end face is enhanced by the relative phase of reflections from the distal end face (8) and the input (4) to the waveguide; and when the distal end face (8) is in air or gas,

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reflections to the input (4) are enhanced by the relative phase of reflections from the distal end face (8) and the input (4) to the waveguide.

9. A microwave applicator comprising a waveguide (1), a coaxial electrical input (4) with an inner conductor (7) extending longitudinally within one end of the waveguide to launch microwaves in the  $TM_{01}$  mode that travel to the distal end (8) of the waveguide and are transmitted into biological tissue to be treated, a diaphragm (20) of low loss dielectric material being provided within the waveguide (1) so as to extend laterally of the waveguide to reflect the microwaves travelling along it, the longitudinal location of the diaphragm (20) being selected in relation to the ends of the waveguide (1) so that the phase of reflections from the diaphragm (20) and said ends serve to reduce or cancel rearward reflections in the coaxial input (4).
10. A microwave applicator as claimed in claim 9 in which the thickness of the diaphragm (20), and the permittivity of the dielectric material from which it is made are selected to determine the magnitude of the rearward reflection of microwaves from the diaphragm (20) for optimum cancellation of the rearward reflection in the coaxial input.
11. A microwave applicator as claimed in claim 9 or 10 which is air-filled.
12. A method of heat treating surface tissue using the microwave applicator of any one of claims 1 to 11 in which the end face (8) of the waveguide (1) is brought into contact with the surface tissue.
13. A method as claimed in claim 12 in which the surface tissue is internal tissue and the applicator is inserted into a body for treatment.
14. A method as claimed in claim 13 in which the insertion of the applicator is via a Trocar.
15. A method as claimed in claim 12 in which the surface tissue is the external skin of the body.

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16. A method of treating a liver in a body comprising providing a microwave applicator having a treatment head at one end capable of emitting microwave radiation from an emitting face, inserting the microwave applicator through an incision into the body positioning the head of the microwave applicator in contact with a surface of the liver with the emitting face adjacent to a region to be treated, and powering the microwave applicator so that the emitting face emits microwave radiation that heats said region to be treated.
17. A method of treating biological tissue to stop bleeding comprising providing a microwave applicator having a treatment head at one end capable of emitting microwave radiation from an emitting face, positioning the head of the microwave applicator in contact with a surface of the biological tissue to be treated with the emitting face adjacent to bleeding tissue to be treated, and powering the microwave applicator so that the emitting face emits radiation that heats the bleeding tissue to be treated.
18. A method of treating a skin condition such as psoriasis using a microwave applicator having a microwave emitting window which is brought into contact with, or into close proximity of, skin to be treated and is powered so as to emit microwave radiation and irradiate the skin to be treated.

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